Milk Quality Improvement Program

2023 Proposals

September 13–14, 2022
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Milk Quality Improvement Program

Vision
Improve New York state dairy product quality and safety from farm-to-table to position NY as the #1 producer of high-quality dairy products and to assure ample processing capacity for raw milk produced in NYS.
Objective 1 – Voluntary Shelf-Life Program

Objective 2 - Microbial Quality and Safety Benchmarking of Key NY Dairy Products

Objective 3 - Support NY Dairy Innovation through Product Development Infrastructure and Technology Transfer

Objective 4 – Support NY Dairy Processing Capabilities

Objective 5 – Rapid Response to NY Dairy Quality and Safety Issues

Preparing the NY dairy industry for eCommerce distribution channels (year 2 continuation)

New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)

Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain (new – 2 years)

Modelling tools to support a resilient NY dairy industry (new – 2 years)

Developing best practices for prevention of sanitizer in milk (new – 1 year)
Dairy Product Quality and Safety Program

Objectives
1. Fluid Milk Voluntary Shelf-Life (VSL) Program
2. Microbial Quality and Safety Benchmarking of Key NY Dairy Products
3. Support NY Dairy Innovation through Product Development Infrastructure and Technology Transfer
4. Support NYS Dairy Processing Capabilities
5. Rapid Response to NYS Dairy Quality and Safety Issues
Objective 1. Voluntary Shelf-Life Program

• In 2021 just over 3 billion lb of NY raw milk was processed into fluid milk, representing an increase over 2018, 2019 and 2020

• With many plant-based milk alternatives available to consumers, avoiding negative consumer experiences with NY fluid milk is critical to ensuring a long-term customer base

• Quality improvements and close industry/academia relationships are critical to positioning the NY fluid milk industry to take advantage of new and emerging opportunities (e.g., new distribution channels)
Objective 1. Voluntary Shelf-Life Program

• Monitor the chemical, microbiological and sensory quality of the NY fluid milk supply through the Voluntary Shelf-life Program to assess individual and overall milk quality in NY

• Provide critical extension support to enrolled facilities to translate findings in order to quickly identify and correct quality and safety deviations that could broadly damage the NYS dairy industry

• Expanded focus on raw milk quality indicators initiated in 2022 will continue in 2023
  • Total bacteria count, psychrotolerant spore count, somatic cell count* and sensory profile
  • Raw milk samples collected as part of the VSL program are sourced from storage at processing facilities
Objective 1. Voluntary Shelf-Life Program

- Identify innovation opportunities and research needs through established relationships with NY fluid milk processors
  - Many fluid milk processors also process other products (cheese, yogurt, ice cream, etc.) – the VSL program provides a pathway to engaging with processors on products beyond fluid milk
- Encourage consumption and promotion of NY fluid milk through the NYS Fair fluid milk awards.
  - Overall Fluid Milk award
  - Small Processor Fluid Milk award
  - Chocolate Milk award
  - Flavored Milk award
Winners of The 2022 Dairy Products Competition Announced Today at The Great New York State Fair

First Place for best overall fluid milk quality
Stewarts Processing
Saratoga Springs, NY

Second Place for best overall fluid milk quality
Dygert Farms Creamery
Palatine Bridge, NY

Small Processor Award
King Brothers Dairy
Schuylerville, NY

Chocolate Milk Award
King Brothers Dairy
Schuylerville, NY

Flavored Milk Award
Weissmann Farms
Roscoe, NY
Objective 1. Voluntary Shelf-Life Program

Key performance indicators:

• Fluid milk quality data for the 33 fluid milk processing plants currently enrolled in the VSL program
• Detailed milk quality parameter analyses that define the winners of the 4 fluid milk related state fair awards and promotion of those awards
• Offer at least 3 workshops and trainings designed to assist fluid milk processors in improving product quality

Benefits for NY dairy producers and dairy industry:

• Ensure that high quality NY raw milk is processed into safe, high quality fluid milk products
• Uniquely position the NY dairy industry to take advantage of new and emerging fluid milk opportunities
• Provide support to dairy product innovators and entrepreneurs through the VSL framework
Objective 2. Microbial Quality and Safety Benchmarking of Key NY Dairy Products

• Microbial quality and safety benchmarking in 2023 will focus on ice cream processed in NY:
  • The $7 billion overall ice cream industry grew 17% in 2020, after roughly 2.4 percent annual growth over the previous decade
• Our goal is to develop baseline data on key microbiological and sensory parameters of NY ice cream
• Results will be communicated directly to individual processors and will identify gaps in the current microbiological parameters used to evaluate ice cream
• Data collected from this research will be used for knowledge transfer directly to the NY ice cream processing industry and also to improve extension services and workshops
Objective 2. Microbial Quality and Safety Benchmarking of Key NY Dairy Products

- In 2023, we will continue monitoring high-risk artisan dairy products for key foodborne pathogens (for example, *Listeria monocytogenes*) as current issues impacting the dairy industry (e.g., workforce shortages) increase the risk of food safety events.
- This non-regulatory monitoring will enhance our ability to proactively identify and address potential food safety issues before they result in public incidences (e.g., recalls, outbreaks) that can damage the reputation of NY dairy products.
Objective 2. Microbial Quality and Safety Benchmarking of Key NY Dairy Products

**Key performance indicators:**
- Ice cream quality and safety data for at least 10 processing plants that utilize NY raw milk
- Data on the detection of Listeria monocytogenes in artisan dairy products which will inform outreach efforts to protect the NY dairy industry from reputation damaging recalls and outbreaks.

**Key benefits for NY dairy producers and dairy industry:**
- Ice cream is a growing market category, but has also had high profile food safety issues in recent years
  - Ensure that NY is poised to provide consumers with high quality, safe ice cream products to capitalize on the growth opportunities
- Reduce the risk of industry damaging recalls or foodborne illness outbreaks
Objective 3. Encourage New York State Dairy Innovation through Product Development Infrastructure and Technology Transfer

• Product development and innovation is essential to growing demand for NYS dairy

• Providing current and prospective NY dairy processing businesses with product development facilities, support and expertise through this objective will continue to facilitate dairy product innovation in NY

• Funding will be leveraged through fees charged for the use of the Food Processing Development Laboratory facilities
Objective 3. Encourage New York State Dairy Innovation through Product Development Infrastructure and Technology Transfer

- Support NY dairy processors in developing innovative products through consultation, in-house support and use of the FPDL
  - Emerging dairy companies that have developed initial prototypes in our facility, including a number of products that have won awards in local and national competitions.
- Support product innovation, development and technology transfer through consulting services, and use of FPDL facilities or existing programs (i.e., the Cheese and Dairy Product Incubator Program)
- Support technology transfer and communication of available services, including through continuation of our “Dairy Product Innovation” events
Objective 3. Encourage New York State Dairy Innovation through Product Development Infrastructure and Technology Transfer

**Key performance indicators:**

- At least 3 outreach events/demonstrations that will facilitate new dairy product development activities at Cornell
- A total of $50,000 of fee-based income from companies that pursue dairy product development activities at Cornell (this income will be used to cover facility and staff support)

**Key benefits for NY dairy producers and dairy industry:**

- Facilitate dairy product innovation, which is essential to grow demand for NY milk, by providing NY processors with access to dairy experts and pilot facilities
- Provides NY processors with access to equipment for processing yogurt, cheese, fluid milk, butter and ice cream at a pilot scale to facilitate NY dairy product innovation
- Provides industry with access to qualified and well-trained staff with the required dairy expertise
Objective 4. Support NYS Dairy Processing Capabilities

• In 2021 over 18 billion lb of milk and dairy products were utilized in NYS dairy plants, up from 15.3 billion in 2010
  • NY has the second largest number of processing facilities in the US

• To **support and expand** the important dairy manufacturing industry in NY, we will offer comprehensive multi-modal training and educational approaches while also developing key relationships between industry, academia and regulatory agencies

• We will continue to pursue leveraged funding for dairy foods related efforts from various sources (e.g., USDA, NDC, etc.)
  • These research and extension efforts preferentially benefit the NY dairy industry through our extensive relationships and extension programming
Objective 4. Support NYS Dairy Processing Capabilities – A Case Study

• In June, 2022 a pilot workforce development program targeting career-ready high school seniors was conducted in partnership between Cornell DFE and Genesee County Economic Development

• Students were introduced to key dairy foods processing concepts, interacted with employees and HR representatives from local dairy processing companies and participated in virtual and in-person dairy plant tours to learn about careers in dairy processing

• This pilot program will expand to other areas of NY in 2023
Objective 4. Support NYS Dairy Processing Capabilities

**Key performance indicators:**

- Conduct at least 35 workshops, reaching at least 750 people
- Raise at least $250,000 through industry workshop fees

**Key benefits for NY dairy producers and dairy industry:**

- Critical support and assistance to NY dairy processors to ensure continued growth of dairy processing capabilities and capacity in NY
- Availability of well-trained dairy processing workforce, which is important for attracting and retaining processors in NY and ensuring product quality and safety
- Workshop fees represent industry contributions to MQIP and dairy foods innovation and research efforts
Objective 5. Rapid Response to NYS Dairy Quality and Safety Issues

- Offering rapid support to the NYS dairy industry when quality or safety issues arise is a critical role that MQIP fulfills
  - Our non-regulatory, multidisciplinary team can rapidly address potential and emerging issues throughout the dairy value chain from producers to processors
- Providing guidance, consultation and technical assistance is needed to prevent negative consequences for the NYS dairy industry
- Identify and address emerging industry wide issues
Preliminary Discovery
- Initial consultation to determine nature of quality defect
- Review previously collected data

Targeted sample collection and analysis to determine causative agent

Alternative Troubleshooting

Plant/Farm Visit
- Case-by-case basis
- Further review of existing data and practices
- Sample collection and analysis

Root Cause Analysis, Recommendations, and Follow up
Objective 5. Rapid Response to NYS Dairy Quality and Safety Issues

Key performance indicators:

- At least 4 articles (e.g., in Cornell Dairy Foods Extension Newsletter) that either advertise the availability of the rapid response team or that report key learnings from performing troubleshooting and root-cause analysis of dairy quality and safety issues.
- At least 4 deployments of the rapid response team

Key benefits for NY dairy producers and dairy industry:

- Minimize the risk of extremely damaging food safety or quality issues linked to NY dairy products, or broader events that affect the dairy industry (e.g., workforce shortages, COVID-19) – insurance function
- Improve NY dairy product quality and safety by assisting NY processors to quickly resolve quality and safety issues
Dairy Product Quality and Safety Program

Overarching project key performance indicators

1. Submission of at least 3 proposals (requesting at least $500,000 total) for dairy related research and extension funding from sources other than the New York State Dairy Promotion Order

2. Publication of at least 3 peer-reviewed papers on program related research findings

3. Publication of at least 3 lay articles based on program related research and extension findings
## 2023 DPQSP Funding Requested

### Past DPQSP DPO Funding Received:
- **2022**: $450,000
- **2021**: $448,400
- **2020**: $448,400

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<td><strong>Salaries &amp; Wages</strong></td>
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<td><strong>Travel (plant visits, workshops, conferences)</strong></td>
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Dairy Product Quality and Safety Program (continuation)

Objective 1 – Voluntary Shelf-Life Program
Objective 2 - Microbial Quality and Safety Benchmarking of Key NY Dairy Products
Objective 3 - Support NY Dairy Innovation through Product Development Infrastructure and Technology Transfer
Objective 4 – Support NY Dairy Processing Capabilities
Objective 5 – Rapid Response to NY Dairy Quality and Safety Issues

Supplemental Project Proposals

Preparing the NY dairy industry for eCommerce distribution channels (year 2 continuation)
New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)
Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain (new – 2 years)
Modelling tools to support a resilient NY dairy industry (new – 2 years)
Developing best practices for prevention of sanitizer in milk (new – 1 year)
Supplemental Project #1 - Preparing the NY dairy industry for eCommerce distribution channels (continuation– Year 2)

• In 2020 grocery eCommerce comprised 10.2% of total grocery sales
  • Fluid milk and natural cheese saw substantial increases in e-commerce sales during the pandemic.
  • Among consumers that purchased dairy products online during COVID-19, 70% indicated that they will continue purchasing online.
• Most of the dairy industry’s activities with regard to eCommerce have focused on advertising, product placement, and similar marketing type activities.
• Unique product quality challenges associated with eCommerce have largely been neglected
  • Efforts in this area are essential to assure long-term success of dairy products in eCommerce.
  • Repeat bad experiences with dairy products that arrive at incorrect temperatures, spoil, or show reduced quality or inability of eCommerce enterprises to reliable answer customer questions carry a tremendous risk of reducing consumer purchases of dairy products, both through eCommerce and traditional channels
    • Specific efforts are needed to proactively address this issue/challenge
New Era of Smarter Food Safety Summit on E-Commerce: Ensuring the Safety of Foods Ordered Online and Delivered Directly to Consumers

Because of the increasing number of consumers ordering their foods online, convening this summit is a goal set in FDA’s New Era of Smarter Food Safety blueprint. The number of consumers ordering food online has been steadily increasing over the years, but it has skyrocketed during the COVID-19 pandemic, according to reports of consumer buying patterns. The blueprint goal is to convene a summit to identify courses of action to address potential food safety vulnerabilities, including those that may arise in the “last mile” of delivery.
Shipping Dairy Products Direct to Consumers

Dec 02, 2020

When Issues Arise

Proactively addressing common customer questions and concerns is necessary when shipping dairy products direct to customers. The resolution of any issues that may arise during the ordering, shipping, delivery process will impact the customer experience and whether they subsequently purchase and have a product shipped to them. Be prepared with resolutions for common issues such as incorrect orders or products arriving at incorrect or unacceptable temperatures. Decide whether to ask the customer to send a picture/description of the package/issue to assist in prevention with future shipping issues. Being able to quickly tell customers the plan for solving the problem will build their confidence and trust in the business.
Supplemental Project #1 - Preparing the NY dairy industry for eCommerce distribution channels (continuation– Year 2)

• Objective 1. Assess the use of different eCommerce dairy distribution chains in NY, including the temperature profiles.

• Objective 2. Use simulated and real eCommerce time-temperature profiles to assess the impact of eCommerce distribution on the quality and shelf life of selected dairy products.

• Objective 3. Develop computer models that can predict the quality and shelf life of dairy products distributed through eCommerce, including products exposed to temperature abuse.
Supplemental Project #1 - Preparing the NY dairy industry for eCommerce distribution channels (continuation– Year 2)

**Preliminary Data:**

- 2 fluid milk processors making direct deliveries, 5 different delivery vehicles, total of 21 separate delivery runs (app. 4-12h each). Each run followed in ½ Gal milk containers in up to three different spots in the delivery vehicle.

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**Truck II 7/27/22**

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**Truck II 7/29/22**

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<td>41.9</td>
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<tr>
<td>8:21</td>
<td>39.9</td>
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</table>
A model framework for spoilage assessment

10,000 iterations (e.g., of half-gallons of fluid milk)
### Predicted shelf-life under temperature abuse

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Predicted proportion of spoiled milk containers at day 14 and 21 (%)</th>
<th>Predicted shelf life&lt;sup&gt;a&lt;/sup&gt; (days)</th>
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<tbody>
<tr>
<td>Baseline (mean temperature of 4.4°C (40 F)&lt;sup&gt;b&lt;/sup&gt;)</td>
<td>38.0; 55.3</td>
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<td>Increase mean temperature during eCommerce distribution to 7.4°C (45 F)</td>
<td>41.2; 59.4</td>
<td>17</td>
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<tr>
<td>Increase mean temperature during eCommerce distribution to 9.4°C (49 F)</td>
<td>46.8; 64.3</td>
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</table>

<sup>a</sup> shelf life is defined as the last date in which at least 50% containers of milk have spore-former concentration less than Pasteurized Milk Ordinance (PMO) limit (20,000 CFU/mL). This limit as well as percentage value are subject to change based on users’ own management preference.

<sup>b</sup> In the baseline model, temperatures during transportation are characterized by a triangular distribution with min = 1.7, max = 10.0, and mode = 4.4. The temperature abuse was implemented by increasing the mode value.
Supplemental Project #1 - Preparing the NY dairy industry for eCommerce distribution channels (continuation– Year 2)

**Key performance indicators:**

- Data on shelf life of fluid milk and yogurt distributed under time/temperature conditions typical for eCommerce
- Data on quality and shelf life of fluid milk and yogurt exposed to temperature aberrations that are likely to occur during eCommerce distribution
- Development of models that can predict quality and shelf life of fluid milk and yogurt distributed under time/temperature conditions typical for eCommerce or exposed to temperature aberrations during eCommerce distribution

**Key benefits for NY dairy producers and dairy industry:**

- Tools and knowledge developed will allow NY industry to successfully compete in eCommerce
- Reduce the risk of eCommerce consumer dissatisfaction
Supplemental Project #1 – Preparing the NY dairy industry for eCommerce distribution channels

Funding Requested

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<td>Indirect Charge (F &amp; A) 18% of total</td>
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<td><strong>Total Proposed Costs</strong></td>
<td><strong>$114,460.00</strong></td>
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Supplemental Project #2 - New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)

- While NY may not produce the most milk in the US, we are uniquely positioned to produce the highest-quality raw milk

- Evaluating raw milk parameters that directly impact processed dairy products is critical to the long-term success of the NY dairy industry as raw milk quality directly impacts finished product quality
  - Somatic Cell Count
  - Total Bacteria Count
  - Sporeforming Bacteria
  - Flavor and Odor Profiles

### Average SCC and Milk Production

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<tr>
<th>State</th>
<th>Average SCC</th>
<th>Milk Production (Million lb)</th>
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<tr>
<td>Idaho</td>
<td>148</td>
<td>16,412</td>
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<td>Michigan</td>
<td>150</td>
<td>11,952</td>
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<td>Pennsylvania</td>
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<tr>
<td>Minnesota</td>
<td>202</td>
<td>10,548</td>
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Supplemental Project #2 - New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (*new – 2 years*)

Objective 1. Recruit NY dairy producers stratified by key parameters and development of a comprehensive farm management survey

Recruit at least 100 NY producers

Stratification by key farm characteristics

Development of a comprehensive farm management survey

Objective 2. Evaluate NY raw milk for traditional and novel measures of quality

Raw milk will be collected and the farm management survey will be administered quarterly for 12 months

Microbiological parameters

Physical and chemical parameters

Sensory profile and overall acceptability score

Objective 3. Define on-farm risk factors for raw milk quality parameters that influence finished product quality and establish data driven guidelines for incentivizing high quality raw milk

Determine the drivers of traditional and novel raw milk quality parameters

Data driven guidelines for incentivizing continued raw milk quality improvement that drives finished product quality
Supplemental Project #2 - New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)

Objective 1. Recruit NY dairy producers stratified by key parameters and development of a comprehensive farm management survey
- Recruit at least 100 NY producers
- Stratification by key farm characteristics
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- Raw milk will be collected and the farm management survey will be administered quarterly for 12 months
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Supplemental Project #2 - New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)

**Objective 1.** Recruit NY dairy producers stratified by key parameters and development of a comprehensive farm management survey
- Recruit at least 100 NY producers
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- Raw milk will be collected and the farm management survey will be administered quarterly for 12 months
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- Sensory profile and overall acceptability score

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- Determine the drivers of traditional and novel raw milk quality parameters
- Data driven guidelines for incentivizing continued raw milk quality improvement that drives finished product quality
Supplemental Project #2 - New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance (new – 2 years)

Key performance indicators:
• Benchmarking data from at least 100 NY dairy producers
• Identification of farm factors associated with traditional and novel measures of quality
• Distribution of project outcomes to NY dairy producers and other stakeholders through at least one webinar and at least three print materials (e.g., fact sheets, infographics, newsletter articles)

Key benefits for NY dairy producers and dairy industry:
• Facilitate a data driven framework for incentivizing traditional and novel raw milk tests that are most relevant for finished product outcomes and affect consumer acceptability
• Distinguish NY as the premier source of high-quality raw milk by establishing quality data that other states do not invest in
• Data will be leveraged to promote the high-quality raw milk produced in NY, attracting new processing businesses to NY
Supplemental Project #2 – New York State Raw Milk Quality: Benchmarking to facilitate continuous improvement and consumer acceptance

Funding Requested

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<td><strong>Total Proposed Costs</strong></td>
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Supplemental Project #3 - Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain (new – 2 years)

- **Raw milk and in-plant sources** can be responsible for contamination with thermoduric bacteria and non-starter lactic acid bacteria that cause defects in dairy products, such as slits and cracks in cheddar cheese

- More than 6.1 billion lb of NY raw milk is used in products susceptible to defects by thermoduric and NSLAB

- Providing tools to the NY dairy industry that allow for differentiation between sources of these bacterial contaminants will facilitate tracking and elimination of defect causing bacteria
Supplemental Project #3 - Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain (new – 2 years)

- Objective 1. Development of testing methods for detection of key thermoduric and NSLAB populations known to cause dairy product defects
  - Focus on screening methods that are targeted toward growth characteristics of thermodurics/NSLAB
  - Evaluate screening methods with isolates in our collection and on raw milk collected from the farm through pre-pasteurization at processing facilities

- Objective 2. Compare isolates obtained to “finished product issues” caused by select thermoduric and non-starter lactic acid bacteria
  - Bacterial agents responsible for quality issues in cheese, yogurt and fluid milk collected from NY processors will be compared to results in Obj 1

- Objective 3. Knowledge and method transfer to allow large cheese manufacturers and other stakeholders to reduce spoilage issues due to thermodurics or non-starter lactic acid bacteria

In order for continued success in New York’s cheese industry, research on how Thermophiles/Thermodurics function and they best way to mitigate them is essential. The more that is known, the faster a manufacturing facility can troubleshoot and find root cause when dealing with these microorganisms therefore allowing focus to be placed on more value added areas.

- Nathan Pistner, Plant Manager, Great Lakes Cheese, & President, NY State Cheese Manufacturers Association
Supplemental Project #3 - Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain (new – 2 years)

**Key performance indicators:**

- Development of one or more microbiological screening tools to detect and track key thermoduric and NSLAB causing finished dairy product quality issues
- Identification of key organisms and sources of thermodurics/NSLAB from raw milk through processing environments and finished products
- Development and distribution of (1) fact sheet, (1) infographic and (1) video to transfer knowledge of both the methods developed here as well as key sources of thermodurics/NSLAB identified in this project (total of 2 fact sheets, 2 infographics and 2 videos)

**Key benefits for NY dairy producers and dairy industry:**

- Improve NY dairy product quality, thereby increasing consumer acceptance, reducing waste and improving opportunities to export markets
- Provide tools to NY dairy processors that will reduce the time needed to troubleshoot and conduct root cause analysis – limiting reducing quality products from entering the marketplace
- Ability to address issue at the correct location – farm versus processing plant
Supplemental Project #3 – Detection, identification and tracking of thermoduric and non-starter lactic acid bacteria throughout the dairy value chain

Funding Requested

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<td><strong>Total Proposed Costs</strong></td>
<td><strong>$94,400.00</strong></td>
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</table>
Supplemental Project #4 - Modelling tools to support a resilient NY dairy industry (new–2 years)

• Effectively managing disruptions is a key need to assure a resilient NY dairy system
  • Even short disruptions can have substantial negative economic effects
  • Disruptions are likely to be more frequent
    • Labor shortages, transportation and supply chain issues, disease outbreaks
• Decision making during disruptions is difficult and often relies on intuition of a few key individuals rather than a rational process that can be optimized over time to yield better outcomes
• Possible decisions that may need to be made include:
  • Can raw milk or cream that is stored for extended time periods, possibly even under slight temperature abuse, still be used to make safe and high quality products
    • What extra steps may need to be taken to be able to safely use these raw materials
  • Can finished product that has been stored “out of specifications” still be safely sold or distributed
A central hub for digital tools that improve dairy processing and products
Emergency Response Research

EPA's emergency response and homeland security research provides science and technology needed to effectively respond to and recover from disasters. Natural and man-made disasters, whether intentional or unintentional, can result in contamination that threatens human health, the environment, and our economy. Communities must be resilient to avoid such catastrophes. Resilience requires scientific information to support good decisions.

Decision Support Tools for Waste Management

Managing waste resulting from disasters can be a complicated and resource-intensive process, especially during large-scale incidents such as the Fukushima Daichi Nuclear Power Plant accident or severe hurricanes. For these large-scale incidents, there is a need for tools to assist state, local, tribal and territorial governments and federal decision makers on waste management in the pre-planning, mitigation, response, and recovery phase of an incident. Current tools that support estimation of waste types and volumes, disposal facility identification, and temporary storage of waste are found in the following table.
Supplemental Project #4 - Modelling tools to support a resilient NY dairy industry (new– 2 years)

• Objective 1. Develop a baseline model that can assess the impact of different disaster and disruption scenarios on quality and safety of fluid milk, cheese, dairy powders, and yoghurt

• Objective 2. Validate the model by comparing model predictions to experimental results and “real-world” data

• Objective 3. Develop and distribute the expert and on-line model versions to relevant dairy system stakeholders
Supplemental Project #4 - Modelling tools to support a resilient NY dairy industry (*new– 2 years*)

**Key performance indicators:**

- Completion of model
- Identification of relevant disaster scenarios through focus groups
- Modelling of 10 disaster scenarios
- Public availability of expert model (Year 2)
- Completion of on-line model

**Key benefits for NY dairy producers and dairy industry:**

- Tools developed will allow NY industry to rapidly make decisions in different emergency, disaster, and disruption situations.
- Reduce the risk of raw milk dumping, dairy product shortages etc.
Supplemental Project #4 – Modelling tools to support a resilient NY dairy industry

Funding Requested

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Supplemental Project #5
- Developing best practices for prevention of sanitizer in milk (new – 1 year)

• Contamination of fluid milk with sanitizers represents a serious risk to the dairy industry as it degrades overall consumer confidence in dairy products
• Practices to detect sanitizers vary between processing facilities, but often rely on a single operator to detect the contamination by smelling the product
• Development of best practices and practical guidance is necessary to reduce the risk of damaging recalls due to sanitizer contamination
Supplemental Project #5 - Developing best practices for prevention of sanitizer in milk (new – 1 year)

• Objective 1. Identify common practices and control strategies that are, at the processor level, in place to prevent adulterations of fluid milk with sanitizers

• Objective 2. Determine the minimum sensorily detectable concentrations of sanitizers in milk by trained sensory panelists, consumers and dairy processing employees

• Objective 3. Identify, evaluate and compare qualitative and quantitative methods for detection of sanitizer contamination in fluid milk

• Objective 4. Develop guidance documents with best practices for detection and prevention of adulterations of fluid milk with sanitizers
Supplemental Project #5 - Developing best practices for prevention of sanitizer in milk (*new – 1 year*)

**Key performance indicators:**
- Identification of common practices and control strategies in fluid milk process facilities
- A matrix of minimum concentrations of sanitizers in milk that can be detected by (i) sensory evaluation and (ii) different chemical test methods.
- A guidance document with best practices for detection and prevention of adulterations of fluid milk with sanitizers.
- Three short “quick train” videos with useful information on results and progression of the project.
- At least one “dairy virtual office hours” dedicated to the issue of milk adulterated with sanitizers where best practices in preventing this issue will be discussed.
- Updated workshop curriculum with best practices for detection and prevention of adulteration of fluid milk with sanitizers.

**Key benefits for NY dairy producers and dairy industry:**
- Reduce damaging impacts of sanitizer contamination in fluid milk
- Improve consumer confidence in the NY dairy industry
- Increase consumer acceptance of fluid milk
Supplemental Project #5 – Developing best practices for prevention of sanitizer in milk

Funding Requested

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<td>Supp. Project 5: Developing best practices for prevention of sanitizer in milk (new – 1 years)</td>
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Summary

• The continuity of the MQIP including the main “Dairy Product Quality and Safety Program (DPQSP)” and associated supplemental projects is essential for growth and vitality of the NY dairy system
  • MQIP provides services and support that ensure the safety and positive reputation of NY dairy products, which are necessary for expanding demand for NY dairy products and dairy ingredients
  • The MQIP infrastructure at Cornell has been proven to reduce the risk of food safety and quality problems that negatively affect consumer confidence and thus would reduce the demand for NY dairy products and ingredients
  • The MQIP provides support for dairy innovators and entrepreneurs from launch to long-term
  • The MQIP has consistently leveraged DPO funding to recruit additional financial support for research and innovation that benefits the NY dairy industry
  • The NY dairy industry relies on the MQIP for NY-centered dairy knowledge, training and education, workforce development and industry-focused applied research
Thanks for Making New York a Great Place for Dairy Research and Outreach!
Technology transfer processing and chemistry research results to industry.

Dave Barbano
Project 1
Goal: To achieve implementation of results, knowledge and technology developed based on research at the Northeast Dairy Foods Research Center and other technological developments that would keep dairy processors in New York State competitive.

How will this project benefit NYS Dairy Producers or the NYS Dairy Industry?
It will keep our farms and dairy processing facilities up to date and competitive with the dairy industry outside of NYS. This will be particularly important for high protein shelf-stable beverages that can be shipped long distances and stored at ambient temperatures.
(1) Milk Beverages – Research Platform

LOOKING BACK

- The influence of UP by indirect versus direct steam injection on skim and 2% milk (Lee et al. 2017)
- Flavor chemistry difference among milk processes by HTST or UP (Jo et al. 2018)
- Identification of source of volatile sulfur compounds produced during thermal processing of milk (Jo et al. 2019)
- Hunter vs CIE color measurement systems for analysis of milk-based beverages (Cheng et al. 2019)
- Effects of milk fat, casein, and serum protein concentrations on sensory properties of milk-based beverages (Cheng et al. 2019)

LOOKING FORWARD

- Reducing sugar in school lunch chocolate milk (Nakamura et al.)
- Milkfat preference in unflavored and chocolate milk (Keefer et al.)
- Role of packaging on unflavored and chocolate milk flavor (Cadwallader et al.)
- Role of complete lactose removal, fat and protein on physical and sensory properties of milk beverages (Hernandez et al.)
- Role of cooling and storage on the flavor of aseptic milk (Cadwallader et al.)
(2) Dairy Protein Beverages – Research Platform

**LOOKING BACK**

- Effect of dairy protein type (MPC and MCC) on beverage flavor and physiochemical properties (Vogel et al. 2021)
- Viscosity and gel formation of MCC (Dunn and Pranata et al. 2021)
- Effect of MCC purity on sulfur eggy flavor in protein beverages (Whitt, Pranata et al. 2022)

**LOOKING FORWARD**

- Role of milk mineral composition, pH and added minerals on heat stability of milk protein
- Dipotassium phosphate impact on milk beverage viscosity and color (Hoyt and Pranata et al.)
- The impact of hot and cold UF on mineral balance and heat stability on MPC (Truong et al.)
- Physical properties heat stability of lactose free micellar casein concentrated model beverages (Knowling et al.)
- The role of retort vs. DSI UP on physical and sensory qualities of protein beverages (Liu et al.)
The wide range of hands on experience with membrane filtration technologies to make high protein dairy beverages and the thermal processing of those beverages that we have building off the research platform provides a unique level of experience to help guide NYS processors as they innovate in this dairy product category.

We provide analytical and trouble shooting support for NYS processors developing new high protein milk based beverage products. Recently, we developed a rapid method using a cryoscope to monitor lactose removal by UF and MF on milk and we helping factories implement that technology.
We have developed a rapid, more-accurate composition method of analysis for Cheddar cheese using Mid-Infrared analysis. We are training and working with a NYS Cheddar plant to implement this method. Once we achieved successful implementation in the first Cheddar cheese plant, then we plan to expand to other NYS Cheddar cheese plants and then modify the method for analysis of other cheeses (mozzarella and cottage cheese). When we understand the needs of these plants, then we can develop strategies to make calibration samples that will improve their ability to achieve consistent composition.

The long term vision is that we want to use mid-infrared spectra of cheeses to predict how well they are expected to age. This would be very useful to identify individual batches of cheese that have a low probability of developing good flavor during aging and make decisions not to age those batches to reduce wasted inventory cost.
Examples:
1) failure of whipping cream. We trouble shoot separation and oiling off problems in whipping cream in NYS when processors are having problems. We use particle size analysis on samples thorough their process to identify a cause and work with the processor to get it corrected.

2) Control of ice cream mix and consistency of freezing. We developed a method using a milk cryoscope to measure the freezing point of ice cream mix to achieve new mix formulation that will freeze correctly and achieve proper overrun.

3) Dairy product manufacturers rely heavily on mid infrared milk analyzers to test many dairy products for process control. We provide support and training for operators of infrared milk analyzers for process control.
Technology Transfer for the NDFRC

Dr. Samuel Alcaine
State of Dairy Research

• In 2019, Wisconsin (#2) launched a $7.8M Dairy Innovation Hub initiative to update equipment, labs, faculty, and personnel across three campuses to support innovative research and technology transfer to their dairy industry.

• In 2020, California (#1) Milk Advisory Board launched the California Dairy Innovation Center to align dairy producers, processors, and universities.

• In 2022, Idaho (#3), has announced that it is planning to invest $23M to build the nation’s largest farm-to-glass dairy research facility, including a state-of-the-art dairy processing pilot plant with a workforce training and education facility in Twin Falls County.
State of the Dairy Center

- Wisconsin Center for Dairy Research
  - $3.4M Check-off Support,
  - $0.9M Industry Projects
  - $0.2M WI State Support

- Western Dairy Center
  - +$2M Check-off Support
  - +1.5M Industry Co-funding Support
  - 15-25 New Students a Year
Project Goals

- Direct Dairy industry outreach and tech connection.
- Collaborative multi-dairy stakeholder outreach to support dairy innovation and workforce pipeline.
- Provide dairy processing and microbiology tech support.
Initial Support: Year 1 - $13,570
Source and control of variation in butter hardness (and high fat dairy products).

Proposed New Project – 2 year

Dave Barbano and MaryAnne Drake

Project 3
The specific goal of the project is to improve consumer satisfaction with the texture (i.e., hardness) of butter and other high fat dairy products (e.g., sour cream, cream cheese, and spreads) produced by NYS milk processing plants.

Performance indicator: increased consumer liking of high fat dairy products with improved textural properties (e.g., softer butter).

How will this project benefit NYS Dairy Producers or the NYS Dairy Industry?

Increased consumer (hotel/restaurant) satisfaction with physical and sensory properties of butter and other high fat dairy products (e.g., cream cheese and cream cheese spreads).

23 million pounds of butter (540 million pounds milk equivalent) was manufactured in NYS in 2020.
Milk fat and cream delivered to a dairy processing factory varies in milk fatty acid composition and melting properties within day and seasonally.

Has this changed in the last 20 years? Large farms and management driven milk cycles has change variation in milk fatty acid composition of milk arriving at a factory across a 24 hour period and this can impact consistency of dairy product characteristics within a day.

TMR feeding and better ration balancing to improve efficiency and lower the cost of milk production. Of particular interest are factors that change the balance of de novo and preformed milk fatty acids. This will change melting properties of milk fat.
Goal: Our goal is to understand the source(s) of variation in butter hardness (and other high fat dairy products).

23 million pounds of 80% fat butter (540 million pounds milk equivalent) was manufactured in NYS in 2020.
268 million pounds of sour cream (20% fat) was manufactured in NYS in 2020.
280 million pounds of cream cheese (33% fat) was manufactured in NYS in 2020.

Part 1 of this goal is addressed in the proposed study: the role of stage of lactation (and fat feeding) on fatty acid composition and bulk milkfat melting properties.

Part 2 of this goal will determine if the crystallization and melting of milk fat within milk fat globules is different than bulk extracted milk fat and the role of cream treatment (heat treatment, cooling rate and storage time) on butter hardness. There is also a possibility that after butter churning, that the way butter is cooled could be used to eliminate some of the variation in butter hardness caused by differences in milk fatty acid composition.
Objective 1 – Determine the impact of stage of lactation (and diet – palm fat feeding) on fatty acid composition and melting properties of milk fat.

We have about 200 milk fat samples from individual cows (Overton and VanAmburgh feeding studies) and individual farms (USDA Federal Milk Markets). We already have fatty acid composition data and we need to collect thermal data on these samples using a Differential Scanning Calorimeter (DSC). Analysis of these samples by DSC will achieve objective 1.
Problem Statement and Approach

Average % Melting Curves

-20°C to 50°C
Untempered
Tempered
Objective 2 – Determine if slow heating and cooling cream or tempering cream before butter making (or temperature cycling butter in process before packaging) can increase the proportion of fat melting below 60 F in the cream.

This would be done by analysis of cream and commercial butter samples on the DSC. Hardness of butter would be measured with a cone probe texture analyzer with a control temperature measurement chamber.
**Problem Statement and Approach**

**Objective 3** – Determine if butter can be softened with a controlled temperature cycling up 68 to 77 F and cooling back to 35 F to cause an increase in the proportion of fat melting below 60 F.
The role of milk salts on heat stability of milk protein in high milk protein beverages

Proposed New Project – 2 year

Dave Barbano and MaryAnne Drake

Project #4
Dairy Beverage Trends

Milk Beverages
Conscious consumption

Milk Protein Beverages
New processing technologies

High-protein products
LOOKING BACK

Effects of milk fat, casein, and serum protein concentrations on sensory properties of milk-based beverages (Cheng et al. 2019)

The influence of UP by indirect versus direct steam injection on skim and 2% milk (Lee et al. 2017)

Flavor chemistry difference among milk processes by HTST or UP (Jo et al. 2018)

Identification of source of volatile sulfur compounds produced during thermal processing of milk (Jo et al. 2019)

Hunter vs CIE color measurement systems for analysis of milk based beverages. (Cheng et al. 2019)

LOOKING FORWARD

Reducing sugar in school lunch chocolate milk (Nakamura et al.)

Milkfat preference in unflavored and chocolate milk (Keefer et al.)

Role of packaging on unflavored and chocolate milk flavor. (Cadwallader et al.)

Role of complete lactose removal, fat and protein on physical and sensory properties of milk beverages (Hernandez et al.)

Role of cooling and storage on the flavor of aseptic milk (Cadwallader et al.)
(2) Dairy Protein Beverages – Research Platform

**LOOKING BACK**
- Effect of dairy protein type (MPC and MCC) on beverage flavor and physiochemical properties (Vogel et al. 2021)
- Viscosity and gel formation of MCC (Dunn and Pranata et al. 2021)
- Effect of MCC purity on sulfur eggy flavor in protein beverages (Whitt, Pranata et al. 2022)

**DAIRY PROTEIN BEVERAGES**

**LOOKING FORWARD**
- Role of milk mineral composition, pH and added minerals on heat stability of milk protein (this project)
- Dipotassium phosphate impact on milk beverage viscosity and color (Hoyt and Pranata et al.)
- The impact of hot and cold UF on mineral balance and heat stability on MPC (Truong et al.)
- Physical properties heat stability of lactose free micellar casein concentrated model beverages (Knowling et al.)
- The role of retort vs. DSI UP on physical and sensory qualities of protein beverages (Liu et al.)
The specific goal of the project is to expand the market and sales for value added high milk protein beverages (more grams protein and calcium per serving than standard milk) produced by NYS milk processing plants.

Performance indicator: Increased manufacturing and sale of shelf-stable of Class 1 milk and dairy beverage products produced in NYS milk processing plants.
High protein (15 to 40 g protein per serving) dairy protein beverages use milk protein concentrates (liquids 7 to 10.5% protein or reconstituted dried milk protein concentrates) produced using membrane filtration.

Dairy protein beverages are given a high heat treatments (120 to 143°C; 248 to 290°F) to produce shelf-stable beverages. However, high heat often causes the proteins to clump and settle out, so a wide range of additives (citrates, phosphates, gels, stabilizers) are added to prevent protein clumping and precipitation. Consumers want clean label beverages without all these additives.

To achieve a clean label we need to understand what each of these additives does and develop new processing technology (e.g., remove heat sensitive proteins, improve soluble milk mineral level and balance during filtration, change the thermal process to reduce heat shock on the proteins) to eliminate the need for these additives.

**Problem Statement and Approach**

Dairy protein beverages use milk protein concentrates (liquids 7 to 10.5% protein or reconstituted dried milk protein concentrates) produced using membrane filtration. Dairy protein beverages are given a high heat treatments (120 to 143°C; 248 to 290°F) to produce shelf-stable beverages. However, high heat often causes the proteins to clump and settle out, so a wide range of additives (citrates, phosphates, gels, stabilizers) are added to prevent protein clumping and precipitation. Consumers want clean label beverages without all these additives.

To achieve a clean label we need to understand what each of these additives does and develop new processing technology (e.g., remove heat sensitive proteins, improve soluble milk mineral level and balance during filtration, change the thermal process to reduce heat shock on the proteins) to eliminate the need for these additives.
Problem Statement and Approach

We have built a new small scale apparatus for giving very repeatable high temperature treatments (100 to 210°C) to a large number of combinations of milk proteins and nondairy additives use to improve physical properties of the beverages.
Problem Statement and Approach
Problem Statement and Approach

Objective 1 (Year 1) – Determine the role of individual milk and non-milk salts (calcium, phosphate, citrate, and other mono and divalent salts) and total ionic strength on physical (heat stability) and chemical characteristics of milk based beverages with different milk protein types and higher protein concentrations when subject to various thermal treatments to produce shelf-stable beverages using oil bath approach.

Objective 2 (Year 2) – Based on the best combinations and concentrations determined in Objective 1, run those formulations on a direct steam injection (142 for 2 to 4 seconds) pilot plant system and pilot plant retort system to determine the impact of heat treatment on physical, chemical and sensory properties of the beverages.
Problem Statement and Approach

Metrics

Protein aggregation – Malvern light particle size analysis
Heat load – furosine and MIR spectra
Apparent viscosity – Brookfield Viscometer
Sensory – flavor and viscosity – descriptive sensory panel
Protein structure degradation – nitrogen soluble fractions
Color – Hunter color meter

Future – Based on results from all of these studies we are working on a design of a better steam injection process to reduce thermal damage to milk proteins in shelf-stable beverages
Leavened Dairy
Build Novel Dairy Fermentation Toolkits
Dr. Sam Alcaine
Creating Innovative Pipelines for Novel Dairy

- Expand the realm of what dairy products can be.
- Create knowledge and technology toolboxes that can be leveraged by large and small dairy producers.
- Create processes that are readily scalable.
  - Norwhey – Implementable using off-the-shelf equipment in the industry
What’s Different With The Yeast

**Brettanomyces – Whey Work**
- Can ferment lactose
- Produces alcohol
- Produce acetic acid (vinegar) with oxygen
- Slower fermentation
- New research for Dairy

**Lactic Acid Yeast**
- Engineered Saccharomyces and Lachancea strains.
- Need lactase to ferment lactose
- Produces Lactic Acid like our bacterial starter cultures
- Phage-resistant unlike start cultures
- Produces some alcohol
- Fast fermentation
- New Research for Dairy
Preliminary Work

pH 4.6 in 7-9 hours
Project Goals

- Continue Yeast Strain Characterization
- Develop Yogurt-like Beverages
- Develop LAY Cheese
- Evaluate Yeast-based Flavor/Product Depth
Project Support

- Senior Scientist
  Fairlife

- Cheese Technologist
  Leprino

- Technical Services Manager
  DSM

- $90K For Project
  (2-3 year project)

- NYDPB
  $45,103 For Year 1
Enabling natural, enzymatic processing technologies to improve dairy product quality and safety

Dr. Sam Alcaine
Natural Enzyme from a mold

Utilizes lactose and generates hydrogen peroxide, which also works synergistically with the natural antimicrobial system in milk.

Remember Lactose Oxidase

Valuable Research
2021 Editors Choice – Journal of Dairy Science
7 Articles with Over 45 citations
Looks nice in there, don’t think I’ll want to get out…

Lactose Oxidase
Lactose Oxidase

Alginate Bead
Preliminary Work
Preliminary Work
Project Goals

- Optimize Bead Production
- Evaluate Beads To Control Spoilage in Milk
- Evaluate Beads To Control Listeria in Raw Dairy
Project Support

$90K For Project (2-3 year project)

Senior Scientist Fairlife

Cheese Technologist Leprino

Technical Services Manager DSM

NYDPB

$44,513 For Year 1
Rare sugar sweetened yogurt

A novel process for better tasting, healthy, and natural dairy-derived sweeteners

Dr. Robin Dando & Dr. Julie Goddard
Julie Goddard

- Industry experience as process engineer for yogurt/pudding
- Chemical Engineering & Food Science Training
- Research: Materials science & enzymology for dairy & food systems

Robin Dando

- Sensory and consumer sciences
- Physiology & Sensory Neuroscience Training
- Research: Sensory and perceptual drivers of food behavior
Sweetener Selection
A driving force for dairy market growth

- Cyclamate
- Aspartame
- Saccharin
- Ace-K
- Thaumatin
- Neotame
- Sucralose
- Xylitol
- Erythritol
- Tagatose
- Stevia
- Allulose
- Luo han guo

Opinion

Very neg.  Neutral  Very pos.
What is a rare sugar

Case Study: Allulose –
• Naturally derived
• Superior sensory properties to most sugar substitutes
• Not classed as an “added sugar” on labels
• Functional properties more alike to sucrose
• Metabolic benefits versus other sweeteners
Allulose and Tagatose have superior taste and metabolic properties to most sweeteners (but are expensive)

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<tr>
<td></td>
<td>Thaumatin</td>
<td>0</td>
<td>0.005</td>
<td>$0.65</td>
</tr>
</tbody>
</table>

Sensory attributes:
- Sweetness
- Bitterness
- Lingering sweetness
- Additional side tastes

Metabolic impact:
- Insulin secretion
- Positive alterations to gut microbiome
- Negative alterations to gut microbiome
- No effect on gut microbiome

None
Consumers want low calorie, natural and good tasting yogurt

Farmers benefit from increased market demand for sweet, no sugar added dairy snacks
Bridging the gap:
Consumer Insights and Sensory Studies Quantifying Consumer Acceptance and Demand

Technology to Convert Lactose to Rare Sugars
Objective 1 – Determine consumer perception of, and sensory response to rare sugar and rare sugar blend sweetened yogurt.

Objective 2 – Production and characterization of enzymes to enable rare sugar production from lactose.
The Path to “Self Sweetened” Yogurt

Sweet like sucrose
No added sugar like high intensity sweeteners
Possible added health benefits
Preliminary sensory data suggests allulose performs well in yogurt formulations.
Projected durations – 2 years
Year 1 Budget - $102,398.50

96% of direct costs requested for 2 graduate studentships
Calories INCREASE for sucrose sweetened yogurt, DECREASE for rare sugar sweetened yogurt

Flavor LESS acceptable without added sucrose; rare sugars maintain “0g Added Sugar”

Lactose converted to rare sugars reduces total carbohydrates

Proposed work maintains clean label & establishes consumer demand

**Nutrition Facts**

<table>
<thead>
<tr>
<th>Serving size</th>
<th>3/4 cup (170g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calories</strong></td>
<td>120</td>
</tr>
<tr>
<td><strong>Total Fat</strong></td>
<td>4.5g</td>
</tr>
<tr>
<td><strong>Saturated Fat</strong></td>
<td>3g</td>
</tr>
<tr>
<td><strong>Trans Fat</strong></td>
<td>0g</td>
</tr>
<tr>
<td><strong>Cholesterol</strong></td>
<td>10mg</td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>85mg</td>
</tr>
<tr>
<td><strong>Total Carbohydrate</strong></td>
<td>10g</td>
</tr>
<tr>
<td><strong>Dietary Fiber</strong></td>
<td>1g</td>
</tr>
<tr>
<td><strong>Total Sugars</strong></td>
<td>9g</td>
</tr>
<tr>
<td><strong>Includes 0g Added Sugars</strong></td>
<td>0%</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>9g</td>
</tr>
<tr>
<td><strong>Vitamin D</strong></td>
<td>0mcg</td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>291mg</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>0mg</td>
</tr>
<tr>
<td><strong>Potassium</strong></td>
<td>384mg</td>
</tr>
</tbody>
</table>

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

**Ingredients:** Cultured Pasteurized Milk, Live & Active Cultures
RESEARCH PROPOSAL

Novel process for the manufacture of shelf stable yogurt powders with live and active cultures

CoPIs: Carmen I. Moraru and Samuel Alcaine
Department of Food Science, Cornell University

NYS DPO Board Meeting
September 8, 2020
Growing market for yogurt

Global yogurt market value forecast 2021-2027

- Increased market and global demand for yogurt, particularly in Asia-Pacific
- Increased demand for products with probiotic properties

Note(s): Worldwide; as of 2022
Source(s): Imarc; Statista; ID 870893
Online yogurt sales: a growing opportunity

- Increase in demand for products that can be sold online
- Opportunity to develop yogurt products with long shelf life and probiotic properties that could be sold online and exported

Source: https://www.alliedmarketresearch.com/yogurt-market
What is currently on the market?

Ingredients
Dextrose, Maltodextrin, Skimmed Yogurt Powder 16%, Lactic Acid, Citric Acid, Flavorings and Silicon Dioxide.

Freeze-dried $2.46 for 1 oz!

Conventionally dried $0.80 per 1 oz.

NO live and active cultures
Project goal

Provide innovative technical solutions for creating shelf stable yogurt products with active cultures
Technology: Microwave Vacuum Drying (MVD)

© Dumpler and Moraru, 2022
Project goal

Provide innovative technical solutions for creating shelf stable yogurt products with active cultures

Project objectives

Year 1

Objective 1: Develop and optimize a vacuum microwave drying (MVD) process for obtaining good quality yogurt powder

Objective 2: Evaluate the quality, shelf life and probiotic content of the MVD yogurt during storage

Objective 3: Explore technical solutions for reconstitution of the MVD yogurt at the point of consumption

Year 2
Objective 1: Develop and optimize a MVD process for obtaining a good quality yogurt powder.

Proposed approaches:
1. MVD of fermented yogurt
   - **Challenge:** Acidity and high water content of yogurt have a negative impact on MVD drying.
   - **Proposed solution:** Reduce the water and lactic acid content by straining the yogurt prior to MVD.
   a) MVD of inoculated yogurt milk & final fermentation after powder reconstitution
      - **Challenge:** Some inactivation of the starter bacteria during MVD
      - **Proposed solution:** Preservation of the viability of the starter culture: a) optimize the MVD process b) design the composition of the starter culture for inoculation based on the different sensibility of different strains to MVD
Anticipated benefits for the NY Dairy Industry

- Innovate the NY dairy industry by creating a product with great potential for both traditional and online markets
- Create opportunities for the NY Dairy Industry to access the export market with novel products
- Improve dairy sustainability by minimizing cold chain needs
Budget request

- Personnel
  - Post Doctoral Associate (10%)
  - Technician (50% Moraru, 50% Alcaine)
  - Lab helper
- Travel (Ithaca to Geneva)
- Pilot Plant Fees
- Equipment Repair and Maintenance
- Business Services (analytical work)
- Laboratory Supplies

Total: $90,000 direct costs; $106,200 including IDC
RESEARCH PROPOSAL

Novel process for the manufacture of shelf stable yogurt powders with live and active cultures

CoPIs: Carmen I. Moraru and Samuel Alcaine
Department of Food Science, Cornell University

NYS DPO Board Meeting
September 8, 2020
RESEARCH PROPOSAL

A High Pressure Homogenization approach for obtaining clean label, extended shelf life cream

PI: Prof. Carmen I. Moraru
Department of Food Science, Cornell University

NYS DPO Board Meeting
September 14, 2022
The amount of cream produced in NY is on the rise (417,508,000 lb of cream and half & half in 2020 alone) (https://agriculture.ny.gov)

Cream has a smaller shelf life than fluid milk

Causes for cream quality and shelf life issues:

- Microbiological (spoilage)
- Physical
  - Creaming
  - Flocculation
- Chemical (oxidation, lipolysis)
Current technological solutions

- **UHT treatment** can increase the shelf life of cream, but has a negative effect on taste, which **negatively impacts** consumption:

- **Increasing viscosity** by homogenization and addition of gums (non-dairy ingredients)
Solution proposed

Use a novel technology (High Pressure Homogenization) to prevent cream quality and shelf life issues, by:

1. Creating a very stable emulsion - prevents creaming and potentially reduces enzymatic activity

2. Additional inactivation of spoilage microorganisms, at temperatures lower than in UHT processing (taste improvement)

Anticipated benefits for the dairy industry:
- Increased cream quality and shelf life
- Increased consumer satisfaction
- Increased cream sales
What is High Pressure Homogenization?

- A process that uses much higher pressures than regular homogenization (45,000 psi vs 2,500 psi)
What happens during HPH?

Coupled thermal & pressure effects
- **Thermal effect (heating):** microbial inactivation
- **Pressure effect:** homogenization

Photo courtesy Dr. F. Harte
Penn State University
Goal of this Project

Develop an effective HPH process to enhance the microbiological and physical stability of cream and replace (partially or totally) non-dairy ingredients in the formulation, while maintaining a very high quality of the finished product.
Research Objectives

- **Objective 1 / Year 1** *(this proposal)*: Optimize the HPH process to obtain physically stable cream of different fat contents

- **Objective 2 / Year 2** *(to be submitted next year)*: Evaluate the effectiveness of HPH treatment on the quality and shelf life of cream
Objective 1 (y1)

Optimize the HPH process to obtain physically stable cream of different fat %

Research approach:

1.1. Determine the optimal temperature-HPH pressure combination that allows the HPH processing of cream with varying fat contents (10-38%)
   - Temperature affects the viscosity of cream
   - HPH pressure affects particle size of fat globules
   - Both affect the effectiveness of the HPH process

1.2. Identify the type and amount of milk protein added to cream with various fat % to stabilize the fat globules in cream
   - HPH effectiveness is limited by the protein to fat ratio
   - Adding milk proteins to cream will allow a higher homogenization pressure to be used
   - This will lead to very small fat globule size, which will improve cream stability
   - This will also increase cream viscosity, which will avoid the need for gums
Budget request

- Personnel
  - Post Doctoral Associate
  - Lab helper
- Travel (Ithaca to Geneva)
- Pilot Plant Fees
- Equipment Repair and Maintenance
- Business Services (analytical work)
- Laboratory Supplies

Total: $91,000 direct costs; $107,380 including IDC
THANK YOU!

A High Pressure Homogenization approach for obtaining clean label, extended shelf life cream

PI: Prof. Carmen I. Moraru
Department of Food Science, Cornell University

NYS DPO Board Meeting
September 14, 2022
Production of Novel, Dairy-based, Nutritionally Supplemented, Snack Products and In-Mouth Dissolving Puffs via Supercritical CO2 Extrusion

Sy Rizvi
SRizvi@cornell.edu
Baby’s First Solid Food & Related Novel Foods

Happy Puffs (Extruded)

- Convenient, melts in the mouth in <30 s
- Low nutrient density, starch-based

Create in-mouth dissolving, milk protein-based puffs

Premiumizing milk protein to deliver better nutrition !!!

Geriatric food!

Other foods!
### Product Comparison

**Formulation**

\[(84\% \text{MPC80} + 14\% \text{Sucrose} + 1\% \text{Lecithin} + 1\% \text{Dimodan}) + 0.4\% \text{SHMP}\]

**MPC Samples**
- Steam
- SCFX

**Market Samples**
- Puffs
- Melties ($48/lb)

### Product Composition

<table>
<thead>
<tr>
<th>Per serving (7g)</th>
<th>MPC-scfx puffs</th>
<th>Market Puffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories (kcal)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Protein (g)</strong></td>
<td><strong>4.6</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>0.08</td>
<td>0</td>
</tr>
<tr>
<td>Total Carbohydrates (Added sugar)-g</td>
<td>1.24 (1)</td>
<td>6 (1)</td>
</tr>
</tbody>
</table>

**Notes:**
- (1) Added sugar.
**In-mouth dissolving Formulations:** Process Parameters & Product Characteristics

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Expansion ratio</th>
<th>Porosity ($\varepsilon$)</th>
<th>Piece density (g/cm$^3$)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td><strong>7.32 ± 0.90</strong></td>
<td>0.81 ± 0.01</td>
<td>0.15 ± 0.01</td>
<td>Product has small to medium cell sizes. Shows in-mouth dissolving within the desirable 30-40 second time frame.</td>
</tr>
<tr>
<td>8</td>
<td><strong>9.17 ± 0.41</strong></td>
<td>0.70 ± 0.02</td>
<td>0.17 ± 0.02</td>
<td>Product has small cell sizes and a powdery texture when bitten. Also shows in-mouth dissolving within the desirable 30-40 second time frame.</td>
</tr>
</tbody>
</table>

Formulation 7: 20SM-P/70MPC-80

Formulation 8: 30LHSM-P/60MPC-80

**Formulation**
- MPC-80: 60-70%
- LHSM-P or SM-P: 19.6-29.6%
- Sugar: 8%
- SHMP: 0.4%
- Lecithin: 2%

**Parameters**
- Feed rate: 35kg/h
- Liquid flow rate: 12.3-12.7kg/h
- SME: 56.0-60.0
- Injection pressure: 1200psi
- CO$_2$ flow rate: 0.8-1.4kg/h
- Product temp: 85°C

**SEM Images of two highest performing In-Mouth dissolving products**

Formulation 7: 20SM-P/70MPC-80

Formulation 8: 30LHSM-P/60MPC-80
Design of In-Mouth Dissolving and Skim Milk Powder-containing Baby Puffs

Hannah Jones
Department of Chemical and Biomolecular Engineering and Food Science, Cornell University

Introduction
Skim milk powder (SMP) is manufactured on an industrial scale to convert milk curd into a liquid milk-like product. This project utilizes SMP in an innovative way by creating a novel, high-protein puff product with comparable mouthfeel and dissolving properties to the current carob-based puffs on the market. Using SMP in addition to milk protein concentrate (MPC) is advantageous for two reasons. SMP provides more moisture than MPC, and its use in puffs would enable a new market for SMP.

Materials and Methods
Established with MPC/SMP ratios of 60%/40%, 70%/30%, and 80%/20% with 3% sugar, maltitol, and low- and high-thermal milling technology, and commercial carob puffs (market product) were compared. The 80% MPC puff was prepared according to the specifications for MPK (Xie and Ross, 2023). During extrusion, CI flow rate, water flow rate, injection pressure, and extruder temperature were manipulated to produce extrudates with in-mouth dissolubility time comparable to the market product.

The methods used to measure physical properties were penis density and expansion ratio (ER). The penis density is a measure of the porosity of the puff, which is defined by the extrusion parameters and affects the size and shape of the puff. The expansion ratio is measured as the ratio of the expanded puff volume to the original volume. For dissolution properties, a three-bite compression test was conducted with a texture analyzer. The test simulates the puff’s behavior in the mouth. The compression was measured in force (N) and displacement (mm) at the point where the puff reaches a certain density. The compressibility of the puff is then determined by the difference in force before and after compression. The puff density was measured using a densimeter.

Table 1. Experimental Extrudate Formulations

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>60%/40% MPC/SMP</th>
<th>70%/30% MPC/SMP</th>
<th>80%/20% MPC/SMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>
| High Pressure Extrusion

Figure 1. High-pressure extruder with ice-cold injection

Figure 2. “Blow” of the dissolubility test in order to obtain a swallower mass.

Figure 3. Bite test force vs. Time graph showing no-soak bite and three successive bites for an SMP puff sample.

Figure 4. Bite test force vs. Time graph showing no-soak bite and three successive bites for an SMP puff sample.

Table 2. Comparing the physical characteristics of the SMP 100, SMP 200, and MPC formulations to a carb. based market sample

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fluctuation (g/cm³)</th>
<th>Expansion Ratio (ER)</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Product</td>
<td>0.12 ± 0.03</td>
<td>14.4 ± 0.80</td>
<td>15.5 ± 0.55</td>
</tr>
<tr>
<td>SMP 100</td>
<td>0.15 ± 0.12</td>
<td>9.77 ± 0.30</td>
<td>15.3 ± 0.60</td>
</tr>
<tr>
<td>SMP 200</td>
<td>0.15 ± 0.13</td>
<td>7.30 ± 0.34</td>
<td>10.15 ± 0.06</td>
</tr>
<tr>
<td>SMP 300</td>
<td>0.12 ± 0.01</td>
<td>6.45 ± 0.80</td>
<td>10.85 ± 0.60</td>
</tr>
</tbody>
</table>

Results
The physical, texture, and dissolubility properties were outlined in the table below. The SMP samples showed improved properties compared to the market product. In addition to the SMP containing puffs, SMP 200 showed a similar curve as the market puff, as can be seen by the sharp curve on the compression test. The compressibility test showed a distinct difference between the market product sample and SMP 200 puffs. Dissolubility based on the three-bite compression test was comparable to the market product.

Conclusion
The addition of SMP that can be further increased in future experiments has led to more moisture in the final product sample and more hardness than the 100% MPC sample while still having a similar mouthfeel characteristics like the market sample. The future goal is to raise the percentage of SMP as much as possible while retaining comparable market product physical, texture, and dissolubility properties.

References

Acknowledgments
I would like to thank Dr. Ray and Jessica Libby for their support, time, and encouragement in pursuing this project.
**Other Formulations: Process Parameters & Product Properties**

**Formulation: Lactose Hydrolyzed Skim Milk Powder**

- **Formulation:**
  - LHSM-P or SM-P: 48.8%
  - MPC-80: 48.8%
  - SHMP: 0.4%
  - Lecithin: 2%

- **Parameters**
  - Feed rate: 35 kg/h
  - Liquid flow rate: 12.3-13 kg/h
  - SME: 56.3
  - Injection pressure: 1200-1600 psi
  - CO₂ flow rate: 1.0-1.5 kg/h
  - Product temp: 85°C

**Soluble Fiber Enrichment: Additional benefit**

<table>
<thead>
<tr>
<th>CO₂ flow rate (kg/h)</th>
<th>% CO₂ Saturation Level in aqueous phase</th>
<th>GOS Concentration (DP3 mg/mL)</th>
<th>DP3 GOS concentration (% wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-extruded Control</td>
<td>--</td>
<td>Present but undetectable</td>
<td>Present but undetectable</td>
</tr>
<tr>
<td>0.75</td>
<td>83</td>
<td>0.15 ± 0.04</td>
<td>0.30</td>
</tr>
<tr>
<td>1.5</td>
<td>167</td>
<td>0.22 ± 0.04</td>
<td>0.44</td>
</tr>
<tr>
<td>2.5</td>
<td>278</td>
<td>0.24 ± 0.05</td>
<td>0.48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO₂ flow rate (kg/h)</th>
<th>% CO₂ Saturation Level in aqueous phase</th>
<th>GOS Concentration (DP3 mg/mL)</th>
<th>DP3 GOS concentration (% wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-extruded Control</td>
<td>--</td>
<td>Present but undetectable</td>
<td>Present but undetectable</td>
</tr>
<tr>
<td>0.75</td>
<td>63</td>
<td>0.12 ± 0.001</td>
<td>0.24</td>
</tr>
<tr>
<td>1.5</td>
<td>115</td>
<td>0.19 ± 0.02</td>
<td>0.38</td>
</tr>
<tr>
<td>Unable to hold 2.5</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Skim Milk Powder-based Formulations: Preliminary Results

### Savory Formulation

- **Flavor:** Salt 3.4%, Nutritional Yeast 1.4%, Garlic Powder 1.4%, Citric Acid 0.3%, Paprika 0.3%

### Base Formulation

- **LHSMP:** 68%
- **Xpander:** 14-15%
- **Rice Flour:** 10-15%
- **Lecithin:** 2%

### Parameters

- **Feed rate:** 35 kg/h
- **Liquid flow rate:** 7.5-8 kg/h
- **SME:** 60.5-63.8
- **Injection pressure:** 1500-1900 psi
- **CO₂ flow rate:** 0.3-0.65 kg/h
- **Product temp:** 85°C

### Table

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Expansion Ratio (RER)</th>
<th>Porosity (ε)</th>
<th>Piece Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>68LHSMP/30Starch (Savory)</td>
<td>5.4 ± 0.2</td>
<td>0.73 ± 0.08</td>
<td>0.18 ± 0.04</td>
</tr>
<tr>
<td>68LHSMP/30Starch (Sweet)</td>
<td>4.6 ± 0.4</td>
<td>0.71 ± 0.04</td>
<td>0.19 ± 0.02</td>
</tr>
</tbody>
</table>

### Sweet Formulation

- **Flavor:** Coffee Powder Conc. 0.3%
Extrusion of Milk Powder & Fruit Pomace-based Formulations

- SM-P
- Lactose Hydrolyzed Skim Milk Powder (LHSM-P)
- MPC-80 or Rice Flour
- Fruit Pomace (Dry powder)

Dry Ingredients

Preconditioning

Water/Liquid Feed

Water/Additives

SC-CO$_2$

<100°C

Supercritical CO$_2$ Extrusion

Vacuum Evaporation

20% Solids Slurry

Pomace Concentrate

Flavor Encapsulation

Pomace slurry
Objectives

- Add apple pomace powder or grape pomace powder to the existing SMP and LHSMP (50-68%) formulations to make these products more nutritionally dense and as a bonus reduce the cost of the overall product.
- Produce dairy based products (both crunchy snack products and in-mouth dissolving products) that are a good source of galactooligosaccharides (GOS).
- Utilize SC-CO2 to encapsulate flavors such as methyl anthranilate within the dairy based products.
Experimental Approach

1. Radial Expansion Ratio
   \[ RER = \frac{D_e^2}{D_a^2} \]

2. Piece Density
   \[ PD \ \text{g/cm}^3 = \frac{\text{mass of extrudates}}{\text{volume of extrudates}} \]

3. Porosity
   \[ \text{Porosity (E)} = \frac{\text{Particle Density} - \text{Piece Density}}{\text{Particle Density}} \]

4. Hardness
   Maximum force during compression up to 70% strain

5. GOS Analysis
   Gas Chromatography

6. Flavor Analysis
   Headspace & Fluorescence Chroma

7. In-mouth Dissolution
   Water hydration, followed by hardness and solubility evaluations.

8. Sensory attributes
   Hedonic testing
Thank You
For your support